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$x=(k+l)[ku_1+k-1]+k+l-1 \ldots\ldots(5)$, which may be reduced to the following form : $x=k[(k+l)u_1+k+l-1]+k-1 \ldots\ldots(6)$.

Thus (5) and (6), which are identical, contain both the forms (3) and (4). Thus if we substitute in the manner indicated the result will contain two original forms. Some special forms required by the problem in question are :

$$x=2u_1+1 \ldots(1);\quad x=3u_2+2 \ldots(2);\quad x=4u_3+3 \ldots(3);\quad x=5u_4+4 \ldots(4);$$

etc., etc. Substitute (1) in (2) in the manner indicated above and we have $x=6u_1+5$. This includes (1) and (2). Substitute this in (3) ; the result is $x=24u_1+23$. This includes (1), (2), and (3) by the previous demonstration. Continuing this we have as a result $x=\underline{|k}u_1+\underline{|k}-1=\underline{|k}(u_1+1)-1 \ldots\ldots(A)$. This contains forms (1), (2), (3), (4), etc., and is the general form of number required. The examples cited are special applications of this general form. Thus $x=\underline{|8}(u_1+1)-1$ contains all the numbers required in the first part of the problem, and, letting $u_1=0$, and $k=25$, we have $x=\underline{|25}-1$, the number required in the last part of the problem.

46. Proposed by A. H. HOLMES, Box 963, Brunswick, Maine.

The base BC of the triangle ABC is $2c$, the sum of the two sides, AB and BC, is $2a$. BP is always perpendicular to AB and cuts AC in P. What is the locus of the point P?

I. Solution by GEORGE LILLEY, Ph. D., LL. D., 394 Hall Street, Portland Ore.

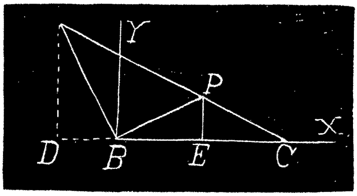
Take BC for the axis of x ; let P be (x, y) ; draw AD at right angles to BC, produced ; and PE at right angles to BC.

Area ABP+area PBC=area ABC, or

$$(a-c)\sqrt{x^2+y^2}+cy=c\times AD \ldots\ldots \ \ldots\ldots(1).$$

Triangles ABD and BPE are similar.

Hence, $AD=[2y(a-c)]/\sqrt{x^2+y^2} \ldots\ldots(2)$.



From (1) and (2), $(a-c)(x^2+y^2)+cy\sqrt{x^2+y^2}=2cy(a-c)$.

$\therefore\ c^2y^2(x^2+y^2)=(a-c)^2(2cy-x^2-y^2)$, for the required locus.

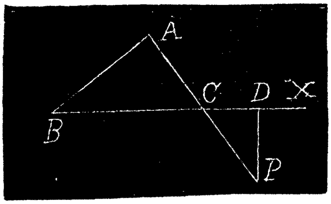
If $\angle ABC$ be an acute angle, y must be taken negatively. Then, area ABC +area BPC=area ABP, or

$$c\times AD+c(-y)=(a-c(\sqrt{x^2+y^2} \ldots\ldots\ldots\ldots\ldots\ldots(3),$$

$$\text{and } AD=[2x(a-c)]/\sqrt{x^2+y^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4).$$

From (3) and (4), $c^2y^2(x^2+y^2)=(a-c)^2(2cx-x^2-y^2)^2$.

II. Solution by G. B. M. ZERR, A. M., Ph. D., Lebanon, Va.



Let B be the origin, Bx the initial line, $BP=r$, $\angle CBP=\theta$, $BC=2c$, $AB=2(a-c)$.

Then $\cos B=\sin\theta$.

$AC=\sqrt{8c^2-8ac+4a^2-8c(a-c)\sin\theta}$.

$CP=\sqrt{4c^2-4rc\cos\theta+r^2}$.

$r^2+4(a-c)^2=AP^2=(AC+CP)^2$.

Substituting and reducing we get for the locus

$$4c^2(r\cos\theta+2a\sin\theta-2c-2c\sin\theta)^2$$

$$=(4c^2-4rc\cos\theta+r^2(\{8c^2-8ac+4a^2-8c(a-c)\sin\theta\}.$$

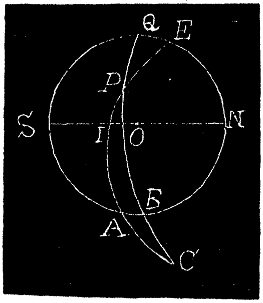
Also solved by *A. H. BELL.*

47. Proposed by S. HART WRIGHT, A. M., Ph. D., Penn Yan, New York.

In longitude 75 degrees west of Greenwich, latitude 43 degrees, 30 minutes north on January 1, 1895, at 3 o'clock A. M., local time. What points of the ecliptic were then rising, setting and on the meridian? Any other necessary data may be taken from an ephemeris.

Solution by the PROPOSER.

January 1, 1895, 3 A. M., in local mean time, at the station, is December 31, 1894, 15th hour astronomical time. And 15h.+5h., the longitude=20h., mean solar time=20h. 3m. 17.1295s. of sidereal time. To this add from ephemeris sidereal time of mean noon at Greenwich, 18h. 39m, 36.83s., and we have 14h. 42m. 52.9595s.$=h$, the sidereal time at station. The vernal equinox is then h hours *west* of the meridian of station, or 24h.$-h$ *east* of it, and therefore $24-(h+6)=$3h. 17m. 7.0405s.=49° 16′ 45.6″$=a$, east of, and below the east point of the horizon of the station.



Let $NQSBN$ be the horizon of station, $EIAC$ a portion of the ecliptic, $QOBC$ a portion of the equator, C the place of the vernal equinox, A the rising point of the ecliptic, I the point then on the meridian, and E the setting point, P the autumnal equinox, and B the point east of the horizon.

Then $BC=a$, the angle BCA, IPO=obliquity of ecliptic=23° 27′ 19″ per ephemeris for the date. The angle ABC=90°+the latitude of station=133° 30′. In the spherical triangle ABC, we have, therefore, the angles B and C given and the side a=49° 16′ 45.6″ to find the side $AC=b$. By spherical trigonometry, b=73° 45′ 15″. In the right spherical triangle IPO, right angled at O, we have $h-12$ hours=2h. 42m. 52.9595s.$=PO$=40° 43′ 14.4″. By spherical trigonometry, PI=43° 10′ 36″. Hence the rising point is 360°$-b$=286° 14′ 45″ of the